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1.0 INTRODUCTION

This Post-Closure Plan has been prepared in accordance with the State of Delaware, Department of Natural Resources and Environmental Control (DNREC) Regulations Governing Solid Waste (DRGSW) to address post-closure care of the Industrial Waste Landfill (IWL) at the Delaware City Refinery (Refinery) located in Delaware City, New Castle County, Delaware (see Figure 1.1 – Site Vicinity Map). The IWL waste management area of approximately 18 acres includes three cells, Cells 1, 2, and 3, as shown on Figure 1.2 – Site Plan.

The IWL is permitted as an industrial waste facility under Solid Waste Permit SW-04/01 issued to Motiva by the Delaware Department of Natural Resources & Environmental Control (DNREC). Closure of this unit as an industrial waste facility is described in a closure plan dated February 2006, in accordance with the DNREC DRGSW, and subsequently revised in October 2007. Post-closure monitoring and care will commence upon closure of the IWL and continue for a period of 30 years.

2.0 SCOPE

Post-closure monitoring and care will include analysis of groundwater samples collected from area monitoring wells, installation of additional groundwater monitoring wells (if necessary), and inspection and maintenance of the groundwater monitoring system, final cover system, passive gas venting system, surface water management system and related aspects (e.g., security).

3.0 POST-CLOSURE UNIT DESCRIPTION

3.1 SITE CONDITIONS AND IWL CONSTRUCTION

The Industrial Waste Landfill (IWL) is located approximately 1,500 feet west of the Refinery's active production areas. The location of the IWL was formerly a petroleum coke pit storage area. The IWL is circumscribed by a nearly continuous perimeter access road and is bordered to the north by low-lying woods, brush and the Norfolk-Southern Railroad; to the west by Schoolhouse Road and to the south and east by Refinery operations. The Delaware River is located approximately 9,000 feet east of the IWL (see Figure 1.1).

The IWL consists of three cells identified as Cells 1, 2, and 3 (see Figure 1.2). The three cells range in size from approximately 5.0 to 6.6 acres. Each of the three cells is underlain by a double-liner system consisting of a primary geomembrane liner overlying a secondary geomembrane. Each cell is also equipped with a leachate collection system (LCS) constructed above the primary liner to facilitate the removal of leachate from the IWL. A leak detection system (LDS) is situated between the two geomembrane liners to monitor the performance of the (upper) primary liner. Typical liner system details are shown on Figures 2.1 and 2.2.

Following its construction, Cell 1 of the IWL received stabilized fly ash from Fly Ash Settling Pond No. 1. The stabilized fly ash exhibited a minimum unconfined compressive strength of 2,000 pounds per square foot (psf). Based on available records, the volume of fly ash received from Pond No. 1 is estimated to be approximately 380,000 cubic yards (cy). Cell 2 construction proceeded while Cell 1 was receiving stabilized fly ash; Cell 3 construction proceeded immediately upon completion of Cell 2 construction.

3.2 WASTE CHARACTERIZATION

In addition to flyash, additional materials placed in the IWL included acceptable wastes as defined by Permit SW-04/01. The wastes were comprised predominantly of off-spec and chunk coke, inert debris, slag, oily dirt and biofilter cake from the Refinery wastewater treatment plant (WWTP). Table 2.1 summarizes the volumes of the various waste materials placed in the IWL based on available records.

4.0 ENVIRONMENTAL SETTING

4.1 REGIONAL SETTING

4.1.1 Climate

In general, New Castle County, Delaware experiences mild winters and warm to hot, humid summers. The coldest part of the year is December through February, with the average minimum temperature of 24.2°F occurring in January. The average maximum monthly temperature (85.7°F) occurs in July.

Precipitation is considered moderate, and is fairly evenly distributed; however, rainfall during the growing season is not uniform, with prolonged wet or dry periods occurring. The average monthly precipitation ranges from approximately 3.03 to 4.56 inches (1960 to 1989 data).[1] An average annual precipitation of 43.4 inches has been calculated based on a 29-year record from the Wilmington climatological station. The Wilmington station is located eight miles north of the Refinery and is representative of climatological conditions at the Refinery and IWL. Snowfall averages approximately 21.1 inches annually, with the first and last frosts typically occurring in mid-October and mid-April, respectively.

The average annual precipitation of 43.4 inches yields approximately 2 million gallons per day per square mile (mgd/mi^2). According to the Water Resources Center from the University of Delaware[2], approximately 60 percent of this amount is taken back into the atmosphere by evapotranspiration, leaving less than 0.8 mgd/mi^2 available for groundwater recharge and surface water discharge.

4.1.2 Regional Geology

The Delaware City Refinery facility lies within the Atlantic Coastal Plain physiographic province, approximately 12 miles south of the Piedmont physiographic province boundary, which is also known as the Fall Line. The Coastal Plain in this region consists of a wedge of unconsolidated sediments deposited on a seaward (southeasterly) sloping crystalline basement. The sediments underlying the Delaware City Refinery have been divided into five geologic units

[1] Climatological Data, 1989 Annual Summary for Wilmington, Delaware, National Oceanic and Atmospheric Administration.
[2] Mather, J.R., and Varrin, R.D., "The Groundwater Flow System in the Delmarva Peninsula," University of Delaware Water Resources Center, Research Project Technical Completion Report for OWRR Project No. A-004-Del, January 1972.

ranging in age from recent (Holocene) to more than 65 million years (Cretaceous). The sequence of these deposits is presented in Table 2.2.

The typical sequence of deposits found at the Refinery area is as follows (in descending order):

- Holocene Age Silts and Clays;
- Columbia Formation (Pleistocene Age);
- Merchantville Formation (Cretaceous Age);
- Magothy Formation (Cretaceous Age); and
- Potomac Formation (Cretaceous Age).

The regional geology is discussed in greater detail in the Woodward-Clyde Consultants (WCC) Report entitled "Hydrogeologic Investigation, Industrial Waste Landfill, Star Enterprise Delaware City Refinery, Delaware City, Delaware," dated February 1991 (Hydrogeologic Investigation).

4.1.3 Regional Hydrogeology

The major aquifers in the Refinery area of New Castle County are the Columbia and Potomac Formations. The Merchantville Formation, which in most of the area separates the Columbia and Potomac Formations, acts as an aquitard due to its fine-grained composition. The general hydrogeology of the major aquifers in the region is discussed in more detail in the aforementioned Hydrogeologic Investigation.

4.1.4 Regional Surface Water Hydrology

Local surface water bodies in the area of the Refinery flow to the Delaware River, as do the majority of surface water bodies in New Castle County. (Some surface water bodies in the western portions of the New Castle County drain to the Chesapeake Bay.) Stream flow is generally maintained through precipitation and, especially during periods of low precipitation, via groundwater discharge.

The Delaware River adjacent to New Castle County is tidal, with an average high tide elevation of 3.2 feet NGVD29, average low tide elevation of –2.4 feet NGVD29 and a mean tide elevation of 0.4 feet NGVD29. The high tide elevation has caused large areas surrounding the Delaware River and its tributaries to be marshlands and/or swamps due to the terrain's generally low elevations.

4.2 SITE ENVIRONMENTAL SETTING

The following sections describe the subsurface, surface water hydrologic, and hydrogeologic conditions in the vicinity of the Industrial Waste Landfill (IWL) based on recent and historical investigations at the Refinery. The subsurface conditions are discussed in greater detail in the WCC report entitled "Geotechnical Investigation Report, Proposed Industrial Waste Landfill, Star Enterprise, Delaware City Refinery, Delaware City, Delaware, January, 1991" (WCC Geotechnical Investigation-Jan 1991). The site hydrogeology is discussed in greater detail in the Hydrogeologic Investigation.

Several test borings and test pits were advanced by WCC in 1990 in the vicinity of the IWL. In addition, nine monitoring wells were installed. The locations of the test borings, test pits and monitoring wells are shown on Figure 3.1; Table 3.1 presents test boring information and Table 3.2 presents a monitoring well data summary. Appendix A presents subsurface information obtained from the completed test borings, monitoring wells, and test pits. Appendix B contains monitoring well permits, well completion reports, and well installation logs.

4.2.1 Site Geology

Representative cross-sections A-A' and B-B' are located as shown on Figure 3.2 and presented on Figures 3.3 and 3.4. The following subsections briefly describe the major subsurface strata (up to 155 feet in depth) in descending order from the ground surface.

4.2.1.1 Holocene Silts and Clays

No tidal flats or streams are located in the northwestern portion of the Refinery, thus Holocene-age deposits (composed of silts and clays) are not present in the IWL area.

4.2.1.2 Columbia Formation

The Columbia Formation extends from the surface to depths ranging from approximately 22 feet to 73 feet beneath the IWL site. The sediments are composed predominantly of sands with varying amounts of silt, clay, and gravel. In some areas, lenses of silts and clays, measuring up to six feet thick, were encountered. These lenses appear to be randomly distributed with no lateral continuity. The elevation (EL) of the bottom of the Columbia Formation ranges from as shallow as EL 31.8 feet NGVD29 in the northwest corner of the site to as deep as EL –3.3 feet NGVD29 in the southeast corner of the site. The general trend reflects decreasing elevation to the east-southeast.

4.2.1.3 Merchantville Formation

The Merchantville Formation, where fully penetrated, extends 25 feet to 45 feet below the Columbia Formation. This formation was found to be typically composed of dark gray to black micaceous silty clay to glauconitic fine sandy silt and clay.

4.2.1.4 Magothy Formation

The Magothy Formation was not encountered in any of the borings drilled in the IWL area. This follows the general trend of little or no Magothy sediments in the vicinity of the Refinery.

4.2.1.5 Potomac Formation

The Potomac Formation was encountered beneath the Merchantville Formation. This formation consists of interbedded light gray, silty, clayey fine sand with variegated gray, red-brown, red, and purple clay. This formation was not fully penetrated during the subsurface exploration program in any of the borings drilled at the site in association with design of the IWL. However, published data indicates the thickness of the Potomac Formation is approximately 540 feet NGVD29 at the site.

4.2.2 Site Surface Water Hydrology

Surface water bodies in the vicinity of the Refinery consist of three readily discernible bodies (see Figure 1.1). These include:

- Delaware River, which borders the eastern edges of the Refinery. The Delaware River is located approximately 9,000 feet east of the IWL.

- Dragon Run Creek to the south and its unnamed tributaries . All are tributaries of the Delaware River. The Dragon Run Creek is located approximately 5,000 feet south of the IWL.

- Red Lion Creek to the north of the Refinery and its unnamed tributaries. All are tributaries of the Delaware River. The Red Lion Creek is located approximately 5,500 feet north of the IWL.

Dragon Run Creek and Red Lion Creek are tributaries of the Delaware River. The Delaware River is not used as a source of drinking water in the vicinity of the Refinery because of its brackish quality; however, the Delaware River is used for industrial purposes. The Delaware River is also used for commercial shipping and recreational boating and fishing.

The United States Geological Survey (USGS) monitors the flow and quality of the Delaware River. The flow is reported to range from approximately 3,000 cubic feet per second (cfs) to 100,000 cfs, with the average flow being approximately 11,000 cfs. The river in the vicinity of the Refinery exhibits tidal characteristics, and varies in elevations between 1 and 6 feet NGVD.

Additional information regarding the flow patterns and velocities of the Delaware River in the vicinity of the Refinery can be found in the document entitled "A Water Quality Modeling Study of the Delaware Estuary," January 1978, Technical Report No. 62, Report No. EPA-903-78-001, Annapolis Field Office, Region III, U.S. Environmental Protection Agency.

4.2.3 Site Groundwater

This section presents a brief summary of the groundwater conditions at the IWL site. A more detailed description of the groundwater conditions for the region, plant area, and IWL site is contained in the Hydrogeologic Investigation described in Section 3.1.2 of the Closure Plan.

Groundwater conditions (water table and first confined aquifer) in the IWL area were initially investigated in 1990 by means of nine monitoring wells installed at eight locations (MW-1S through MW-8S and MW-1D). Monitoring wells MW-9S, MW-10S, and MW-11S were added to the monitoring network in 1993. The locations of the monitoring wells are listed in Table 3.2. Reports of monitoring wells, well permits and monitoring well completion reports are presented in Appendix B. The groundwater elevation in the (unconfined) aquifer is approximately EL 28 feet NGVD, with a gradient of 0.0017 ft/ft towards the east. The upgradient well for the aquifer is MW-4S. The downgradient wells are MW-2S, MW-3S, MW-9S, MW-10S, and MW-11S.

The first confined aquifer at the site, the Potomac Formation, was investigated with one deep well (MW-1D). The primary purpose of this well was to assess water quality. The groundwater elevation in this well ranges from approximately 1 foot above mean sea level to 3 feet below mean sea level, which is consistent with the other Potomac Formation wells at the Refinery.

5.0 POST-CLOSURE PLAN

Closure of the IWL is designed to isolate the IWL from the environment and minimize leachate generation. Post-closure monitoring, inspection, and maintenance will minimize the potential for leachate migration into the groundwater resulting from an unlikely but potential breaching or failure of the leachate collection/liner system or final cover system.

The post-closure activities required for the IWL will involve a continuation of the existing groundwater sampling and analysis plan (see Appendix C) upon completion of the IWL closure program and initiation of a post-closure inspection and maintenance program. The following sections describe the legal and technical processes required to comply with the applicable parts of the DNREC regulations.

5.1 LIMITS OF WASTE MANAGEMENT AREA

A survey of the as-built final grades will be performed upon completion of the IWL closure operations. This survey will be referenced to permanent survey monuments. The survey will be performed by a professional land surveyor licensed in the State of Delaware. The final grades will be added to the survey plan prepared in accordance with the Closure Plan.

5.2 ENVIRONMENTAL COVENANT

Following approval of the IWL closure by the DNREC, Motiva will record an environmental covenant in accordance with Title 7, Chapter 79 of the Delaware code of regulations. The environmental covenant will:

- State that the instrument is an environmental covenant executed pursuant to this subchapter;
- Contain a legally sufficient description of the real property subject to the covenant;
- Describe the activity and use limitations on the real property;
- Identify the holder (owner);
- Be signed by the DNREC, all owners of the real property subject to the covenant and the holders with the formalities for a deed; and

- Identify the name and location of any administrative record for the environmental response project reflected in the environmental covenant.

In addition, the environmental covenant may contain other information, restrictions, and requirements agreed to by the persons who signed it, including any:

- Requirements for notice following transfer of a specified interest in, or concerning proposed changes in use, applications for building permits, or proposals for any site work affecting the contamination on, the property subject to the covenant;
- Requirements for periodic reporting describing compliance with the covenant;
- Rights of access to the property granted in connection with implementation or enforcement of the covenant;
- A brief narrative description of the IWL unit and closure, including the contaminants of concern, the pathways of exposure, limits on exposure, and the location and extent of the contamination;
- Restriction or limitation on amendment or termination of the covenant in addition to those contained in § 7913 and § 7914 of this title;
- Rights of the holder in addition to its right to enforce the covenant pursuant to § 7915(c) of this title

Additional details of the environmental covenant, such as validity, relationship to other land use law, notice, recording, duration, amendment or termination by consent, enforcement of environmental covenant, registry/substitute notice, uniformity of application and construction, relation to electronic signatures in global and national commerce act, and serviceability, are described in Title 7, Chapter 79 of the Delaware code of regulations.

5.3 SITE MAINTENANCE

The post-closure unit (closed IWL) will be maintained throughout the post-closure period. The contact person during the post-closure period will be the Delaware City Refinery Environmental Manager, who can be reached by mail or telephone at the following location:

Valero Delaware City Refinery
4550 Wrangle Hill Road
Delaware City, DE 19706
(302) 834-6000

5.3.1 Security

The Refinery implements routine guard checks and other high-level security measures to control unauthorized entry within the Refinery's boundaries, including single and double-chain-link fencing around the perimeter of the facility. Legitimate access to the IWL area can only be gained by passing through controlled gates reserved for employees and contractors/vendors performing functions associated with plant operations. The plant perimeter patrols and the fencing discourage public access to the IWL area.

The condition of the IWL security will be examined during regular inspections of the IWL final cover system and related systems. In particular, any breach to fence integrity (tears or breaches in mesh, digging under fence), evidence or presence of traffic or construction and evidence or presence of unexpected activities will be documented and reported to the Refinery. Emergency contacts are also provided in Appendix D.

5.3.2 Inspection and Maintenance

The IWL final cover system, passive gas venting system and surface water management system will be inspected for the items listed in the Post-Closure Inspection and Maintenance Schedule/Checklist included as Table 4.1. Inspections will be conducted by qualified personnel. A written report of each inspection will be prepared and maintained at the Refinery. If any of the above items require repair or replacement, steps will be taken to correct the problem in a timely manner.

Any non-emergency maintenance cited as a result of inspections will be completed as soon as possible to preclude further damage and to reduce the need for emergency repairs. The non-emergency maintenance activities will include reseeding areas of insufficient vegetation, removal of any plants having a deep-root system including trees, and the backfilling of small washout rills/gullies due to erosion. Maintenance activities of any type will also be recorded in the inspection logs to provide documentation and continuity of records.

5.4 GROUNDWATER MONITORING

Groundwater monitoring will be continued during the post-closure period in accordance with the groundwater monitoring program conducted during IWL operations. The IWL Groundwater Sampling and Analysis Plan is presented in Appendix C.

5.5 POST-CLOSURE LEACHATE CONTROL

Leachate generated during the post-closure period will either be treated onsite at the Refinery Waste Water Treatment Plant (WWTP) or transported for off-site treatment. As described in the Closure Plan, results of the HELP modeling indicate leachate generation will be greatest during the first year following final cover installation and then reduce rapidly over the next 5 years to negligible values. Leachate generation during the remaining 25 years of the post-closure care period is expected to be negligible. Table 4.2 summarizes the expected leachate generation following installation of the temporary synthetic cover and final cover systems. Assuming this condition is confirmed by regular monitoring of leachate generation rates during the post-closure care period, the leachate collection/detection systems and all appurtenances necessary to convey leachate generated within the IWL would only need to be operated and maintained throughout the first 5 years of the post-closure period.

5.6 ESTIMATED POST-CLOSURE COSTS

Costs associated with post-closure care monitoring and maintenance (M&M) consist of a number of items. All post-closure costs for a 30-year post-closure period are based on 2007 dollars and presented on Table 4.3. As shown on Table 4.3, the post-closure M&M costs are expected to total approximately $492,000 in the first year of post-closure care, $192,000 in the second year of post-closure care, and $97,000/year for the remaining 28 years of post-closure care.

5.7 POST-CLOSURE LAND USE

No plans exist at this time for use of the post-closure unit during the post-closure period. Any change in this plan will be submitted to DNREC as an addendum to the Closure and Post-Closure Plan.

6.0 CONTAMINANT MIGRATION

Evaluation of the expected performance of the post-closure unit (closed IWL) involves review of the potential exposure pathways. The critical or most severe pathway for potential exposure is a function of the contaminant concentration, toxicity characteristics, and mobility. In the case of the IWL, the critical pathway for soluble contaminants is a hydrological route; for volatile contaminants, an airborne route; and for biologically accumulative materials, a biotic transport route through vegetation.

The following migration pathways have been reviewed:

- Groundwater contamination (drinking water);
- Surface water contamination (drinking water);
- Direct soil exposure (intrusion into surface soil due to construction activity or farming, and airborne soil particulates); and
- Vegetation uptake and consumption by wildlife.

The following four subsections discuss, in more detail, how the closure of the IWL will mitigate future contaminant migration.

6.1 GROUNDWATER

The potential for contaminant migration to groundwater is controlled by many factors, including geologic conditions, the amount of water available for transport, the driving gradient, and the chemical interaction of the contaminant(s) with the soil and/or water. The design features that mitigate the potential for leachate migration from the IWL include the IWL final cover system, stormwater controls, and the liner/leachate collection system. Free water existing in the in-place landfill material after closure will drain to the leachate collection system, thus, maintaining a low driving head of leachate. The cover system minimizes infiltration, which reduces the potential for leachate generation. Potential for groundwater contamination will be reduced due to the limiting of infiltration into the in-place landfill materials by the final cover system and the liner/leachate collection system underlying the in-place landfill materials.

6.2 SURFACE WATER CONTAMINATION

As shown on Figure 1.1, the IWL is located relative to the following surface water bodies:

- Delaware River, approximately 9,000 feet east of the IWL;
- Dragon Run Creek, approximately 5,000 feet south of the IWL; and
- Red Lion Creek, approximately 5,500 feet north of the IWL.

In the area immediately surrounding the Refinery, none of these surface water bodies is used as a source of drinking water.

Following closure, rainfall/runoff will be directed away from the area of the IWL. The final cover system should prevent runoff from contacting the in-place landfill materials, thus, preventing any contamination.

6.3 DIRECT SOIL EXPOSURE AND VEGETATIVE UPTAKE

The installation of the final cover system should preclude direct contact with in-place landfill materials following closure. The restrictions on land use at the area of the post-closure unit preclude direct soil exposure. In addition, site security procedures will prevent unauthorized personnel from entering the area.

The potential for uptake of contaminants by plants is minimized by the final cover system, which separate the in-place landfill materials from the surficial vegetative cover. The shallow-rooted cover vegetation further minimizes uptake potential.

6.4 AIRBORNE MIGRATION

After closure is completed, airborne migration of landfill materials should be negligible due to presence of the final cover system.